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I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

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Dated 29 July 2004

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24JUN03 E817340-1 C87865
P01/7700 0.00-0314655.2

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1. Your reference

P00137

2. Patent application number
(The Patent Office will fill in this part)

0314655 2

24 JUN 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

BPB plc
Park House
15 Bath Road
Slough
SL1 3UF

Patents ADP number *(if you know it)*

7261555003

If the applicant is a corporate body, give the country/state of its incorporation

UK

4. Title of the invention

Method and Apparatus for Producing a Multilayer Cementitious Product

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

~~Helga Chapman & Co~~
~~The Old Cottage~~
~~Mount Lane~~
~~Barford St Martin~~
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~~SP3 4AG~~

CHAPMAN MALONY
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UPPER WOODFORD
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Patents ADP number *(if you know it)* Acc 08617748001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

yes

Patents Form 1/77

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Continuation sheets of this form	
Description	7
Claim *(s)*	3
Abstract	1
Drawing *(s)*	3 only RM

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Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature: Helga Chapman & Co — Date: 23-06-03

12. Name and daytime telephone number of person to contact in the United Kingdom: Helga Chapman - 01980 863 869

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Method and Apparatus for producing a Multilayer Cementitious Product

This invention relates to a method and apparatus for producing a cementious product such as a prefabricated building component. Examples of such products include gypsum plasterboards, partition panels, ceiling tiles, glass reinforced gypsum boards and gypsum fibre boards.

Products such as gypsum plasterboard are produced from the basic materials, paper in the form of cardboard, plaster (stucco), water, starch and additives such as an accelerator and foam. Other additives known in the art of making plasterboard such as retarders (e.g. proteins, organic acids), viscosity modifying agents (e.g. superplasticisers), anti-burning agents, water-resisting chemicals (e.g. polysiloxanes, wax emulsions), glass fibres, fire-resistance enhancers (e.g. vermiculite, clays and/or fumed silica) and polymeric compounds (e.g. PVA, PVOH) may be added. Wallboards or plasterboards are large thin gypsum panels covered with cardboard.

The plaster used is made either from natural gypsum (calcium sulphate dihydrate), or synthetic gypsum produced as a by-product of some chemical processes, usually in the β-form. The by-product form most commonly used arises from the flue-gas desulphurisation process in use at a number of coal burning power stations, and is known as desulphogypsum (DSG), which typically is above 95% pure gypsum. Other high quality synthetic forms, such as phosphogypsum and titanogypsum may be used where there is difficulty in obtaining DSG.

The synthetic gypsum is already in powder form when it is delivered to the plasterboard factory. However it usually has high free moisture content and typically requires drying before the next stage, calcination. Comminution of natural gypsum is necessary, and usually during this stage the gypsum is dried. The next stage is known as calcination and removes the chemically combined water of crystallisation content to produce plaster powder (stucco). This entails turning calcium sulphate dihydrate (gypsum) into calcium sulphate hemihydrate.

This powder is then mixed with water to produce a slurry. The slurry produced is then fed onto a continuous sheet of cardboard, covered with a second sheet of cardboard and then passed over a moulding platform to be shaped into an encased strip. This strip of gypsum plasterboard is initially soft but then quickly sets as the calcium sulphate hemihydrate rehydrates back to calcium sulphate dihydrate and therefore hardens and is cut into separate panels. The panels are dried and finished as required.

Ceiling tiles and partition panels are produced by a similar process although the slurry is poured into moulds to produce the desired shape and size. If fibreboards are required the slurry also contains fibres such as cellulose, paper or glass fibres.

The setting and hardening of the slurry can be controlled by numerous additives. Seed accelerators (heterogeneous nucleation) are commonly used to enable the slurry to set more quickly and are typically calcium sulphate dihydrate deliberately ground to a high specific area (above 1.5 m^2/g, typically 3-5 m^2/g as measured using BET/nitrogen surface area analysis). Further, the use of co-grinding agents is used to improve the potency and consistency of such accelerators. These co-grinding agents can also temporarily protect the calcium sulphate dihydrate accelerator from acting as a nucleation site when initially mixed with water. For plasterboard manufacture between 0.1 and 2% (w:w stucco) of a seed accelerator is used, but typically 0.5% (w:w stucco), is used. In addition soluble salts such as potassium sulphate (K_2SO_4) are known accelerators that advantageously influence the solubility kinetics of calcium sulphate solutions.

It is known that to produce plasterboard with improved sound absorbing qualities then low purity (usually <90%) natural gypsum is used. The impurities present in this low purity gypsum, in particular clays, are considered to increase the acoustic performance by improving the internal damping characteristics and reducing the board stiffness. Further, the increased mass of the plaster necessary to produce plasterboard when using low purity natural gypsum also improves the acoustic performance. However, the presence of other impurities in this low purity natural gypsum can cause difficulties in processing the material. For example, the use of anti-burning agents, increased starch or water usage, or other additives are required to counteract the presence of these deleterious impurities. It is also known that simply increasing the mass of plasterboard made from high purity gypsum, such as DSG will result in a higher board stiffness.

An aim of the present invention is to alleviate the aforementioned problems associated with producing gypsum board products.

According to the present invention there is provided a method of preparing gypsum board as claimed in the accompanying claims.

Further, according to the present invention there is provided a method of preparing gypsum board comprising the steps of:

a) combining calcium sulphate hemihydrate (stucco) with water to form an aqueous slurry,

b) adding uncalcined gypsum to said slurry,

b) discharging the slurry onto a support so as to form a sheet of gypsum board

wherein said uncalcined gypsum has a specific surface area below 0.5 m^2/g.

Preferably the uncalcined gypsum is dried before being added to said slurry.

The uncalcined gypsum may be present in the composition within the range of about 5 to 50% w:w of the stucco.

More preferably the uncalcined gypsum may be present in the composition within the range of about 10 – 30% w:w of the stucco.

More preferably the uncalcined gypsum may be present in the composition within the range of about 10 -20% w:w of the stucco.

The composition may further comprise existing wallboard crushed or milled and added to the slurry to provide additional bulk to the wallboard mixture.

The uncalcined gypsum may be synthetic gypsum.

Also according to the present invention there is provided a cementitious composition comprising a mixture of stucco, uncalcined gypsum and water wherein at least some of the uncalcined gypsum has a specific surface area below 0.5 m^2/g.

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic view of the apparatus according to an embodiment of the present invention.

Figure 2 is a flow chart illustrating the prior art method of manufacturing a standard gypsum board.

Figure 3 is a flow chart illustrating an embodiment of the present invention.

Figure 3a is a flow chart illustrating a further embodiment of the present invention.

Figure 4 is a Particle Size Distribution (PSD) for an uncalcined synthetic gypsum, DSG as employed as present in the plasterboard mixture according to the present invention.

Figure 5 shows the microstructure of plasterboard containing an uncalcined synthetic gypsum, DSG filler according to the present invention at 100x normal magnification.

Referring to figure 1 a first layer of paper 10 is fed from a roll 12 onto a conveyor or belt 14. A storage container 16 contains slurry of calcium sulphate hemi hydrate and water. This storage container 16 is provided with an outlet 18 connected to a conduit 20. A meter is connected to said conduit 20 for measuring and controlling the amount of stucco fed through the conduit 20.

A further conduit 24 is connected to said conduit 20 and two further storage containers 26 and 28. Each storage container 26, 28 contain appropriate additives used in the plasterboard process. Such additives may comprise retarders (e.g. proteins, organic acids), viscosity modifying agents (e.g. superplasticisers), anti-burning agents, water-resisting chemicals (e.g. polysiloxanes, wax emulsions), glass fibres, fire-resistance enhancers (e.g. vermiculite, clays and/or fumed silica), polymeric compounds (e.g. PVA, PVOH) and other conventional additives imparted in known quantities to facilitate manufacturing.

Conduit 24 is connected at its outlet to a mixer 30. A water container 32 is connected to the conduit 36 of a further additive storage container 34. The container 34 stores further additives such as foaming agents or water. The mixer is provided with an outlet 40 to deliver its combined contents in the form of slurry onto the paper 10. Uncalcined synthetic gypsum is blended with the stucco and then added directly into the mixer 30 via storage container 42.

This mixture is then delivered through an outlet pipe 40 onto the paper 10 provided on the moving belt 14.

The slurry stream 48 is then provided with a bonding agent or adhesive and a further layer of paper 46 is provided over its upper surface. The slurry if therefore sandwiched between two sheets of paper or cardboard 10 and 46. These two sheets become the facing of the resultant gypsum board.

The thickness of the resultant board is controlled by a forming station 50 and the board is subsequently prepared by employing appropriate mechanical devices to cut or score fold and glue the overlapping edges of the paper cover sheets 10, 46. Additional guides maintain board thickness and width as the setting slurry travels on the moving conveyor belt. The board panels are cut and delivered to dryers to dry the plasterboard.

Now referring to the flow chart of figure 2 the known method of producing plasterboard is shown simplistically. Synthetic gypsum is delivered to the factory in the form of powder with a high free moisture content which requires drying. This moist synthetic gypsum powder 41 is delivered to a dryer 43 which removes the free water (moisture) from the synthetic gypsum powder to produce a dried uncalcined gypsum powder. In general the as-received synthetic gypsum, which has a free moisture content between 5-25% is processed through a purpose-built drying mill. This mill will disagglomerate any agglomerations; there is no comminution of the gypsum at this stage of the process. Hot combustion gases at approximately 450°C are used to remove the free moisture, but without causing any calcination of the gypsum.

The next stage 45 known as calcination entails turning calcium sulphate dihydrate ($CaSO_4.2H_20$) into calcium sulphate hemihydrate ($CaSO_4.½H_20$). This calcined gypsum (stucco) is then fed into the plasterboard process via the storage container 16.

The flow chart of figure 3 indicates one embodiment of the present invention. In this embodiment, some of the uncalcined synthetic gypsum, which has been dried in the dryer 43, is removed and blended with the stucco before being fed directly into the mixer 30.

This uncalcined synthetic gypsum is mixed with the slurry such that the mixture for the plasterboard contains approximately 80% calcined synthetic gypsum and 20% uncalcined synthetic gypsum. However a range of 10 – 30% uncalcined synthetic gypsum is preferable. A range of 5% to 50% uncalcined DSG would be acceptable.

In this embodiment of the invention the uncalcined synthetic gypsum added as an additive to the mixer 30 has been dried in the conventional manner before entering the mixer. However in another embodiment of the invention as shown in figure 3a the synthetic gypsum is not dried and is added to the slurry in the mixer 30 in its untreated form containing a high moisture content (5-25% free water). Water can be added to improve processing. Advantageously, this embodiment enables the process to require less process water, eliminates the drying stage and hence reduces costs.

Figure 3a also shows an additional input, 49, of recycled plasterboard which provides additional 'bulk' to the plasterboard being manufactured. This additional bulk further improves the acoustic properties of the plasterboard.

It is also envisaged that the uncalcined gypsum could be added directly into the mixer as a slurry (i.e. mixed with water).

The uncalcined synthetic gypsum does not act wholly as an accelerator when added to the mixer, as would normally be expected, since the particles of the gypsum are too large and remain inert.

Figure 4 is a typical particle size distribution (PSD) for a synthetic gypsum, DSG used in the present invention. The specific surface area (SSA) for such a DSG is below 0.5 m^2/g.

Figure 5 is an example of the uncalcined DSG distribution in the final plasterboard mixture. The DSG particles are clearly visible as the larger dark structures 51.

Advantageously the use of uncalcined DSG to provide additional weight and hence acoustic properties to the wallboard is cost effective since the DSG is already available for the process.. No other additives are needed to combat the effect of un-calcined DSG as a 'filler' since it does not react with any of the constituents of the process and so advantageously reduces the board stiffness for improved acoustic performance. It therefore acts as an inert filler effectively providing 'bulk' to the plasterboard hence improving the acoustic properties of the board.

CLAIMS

1. A method of preparing gypsum board comprising the steps of;
a) combining calcium sulphate hemihydrate (stucco) with water to form an aqueous slurry,
b) adding uncalcined gypsum to said slurry,
b) discharging the slurry onto a support so as to form a sheet of gypsum board
wherein said uncalcined gypsum has a specific surface area below 0.5 m^2/g.

2. A method of preparing gypsum board as claimed in claim 1 wherein the gypsum is dried before being added to said slurry.

3. A method of preparing gypsum board as claimed in claim 1 wherein the unclacined gypsum is mixed with water and added into the mixture as a slurry.

4. A method of preparing gypsum wallboard as claimed in claims 1 to 3 wherein the uncalcined gypsum typically has a particle size distribution within the range of 10 – 500microns.

5. A method of preparing gypsum wallboard as claimed in any one of the preceding claims wherein the uncalcined gypsum is present within the range of 5 to 50% weight on weight (w:w) of the calcium sulphate hemihydrate.

6. A method of preparing gypsum wallboard as claimed in any one of the claims 1 to 4 wherein the uncalcined gypsum is present within the range of 5 to 50% weight on weight (w:w) of the calcium sulphate hemihydrate.

7. A method of preparing gypsum wallboard as claimed in any one of the claims 1 to 4 wherein the uncalcined gypsum is present within the range of about 10 -25% w:w of the calcium sulphate hemihydrate.

8. A method of preparing gypsum wallboard as claimed in any one of the preceding claims 1 to 3 wherein the uncalcined gypsum is present in the composition in an amount of about 20% by w:w of the calcium sulphate hemihydrate.

9. A method according to any one of the preceding claims wherein existing gypsum wallboard is crushed to a suitable size and added to the slurry to provide additional bulk to the wallboard mixture.

9. A cementitious composition comprising a mixture of a cementitious material, water and desulphurisation gypsum wherein the specific surface area of at least some of the desulphurisation gypsum is below 0.5 m^2/g.

11. A cementitious composition according to claim 10 wherein the size of at least some of the desulphurisation gypsum (DSG) particles are within the range of 10 -500microns.

12. A cementitious composition according to claims 10 or 11 wherein the desulphurisation gypsum is present in the composition in an amount of about 5 to 50% w:w of the stucco.

13. A cementitious composition according to claims 10 or claim 11 wherein the desulphurisation gypsum are present in the composition within the range of about 10 – 30% w:w of the stucco.

14. A cementitious composition according to claims 10 or 11 wherein the desulphurisation gypsum are present in the composition within the range of about 10 -20% w:w of the stucco.

15. A cementitious composition according to claims 10 or 11 wherein the desulphurisation gypsum are present in the composition in an amount of about 20% w:w of the stucco.

16. A cementitious composition according to any one of the claims 10 to 15 further comprising existing wallboard crushed or milled and added to the slurry to provide additional bulk to the wallboard mixture.

17. A cementitious composition according to any one of claims 9 to 16 wherein the gypsum is uncalcined synthetic gypsum.

18. A method of manufacturing a cementitious composition substantially as described herein with reference to the accompanying drawings.

19. A cementitious wallboard produced by the method of claim 1.

20. A cementitious wallboard containing the composition of claim 10.

Abstract

Gypsum plasterboard is produced by combining calium sulphate hemihydrate (stucco) with water to form an aqueous slurry. Uncalcined gypsum having a specific surface area below 0.5 m^2/g is added to the slurry and the slurry is discharged onto a support so as to form a sheet of gypsum plasterboard.

Figure 1

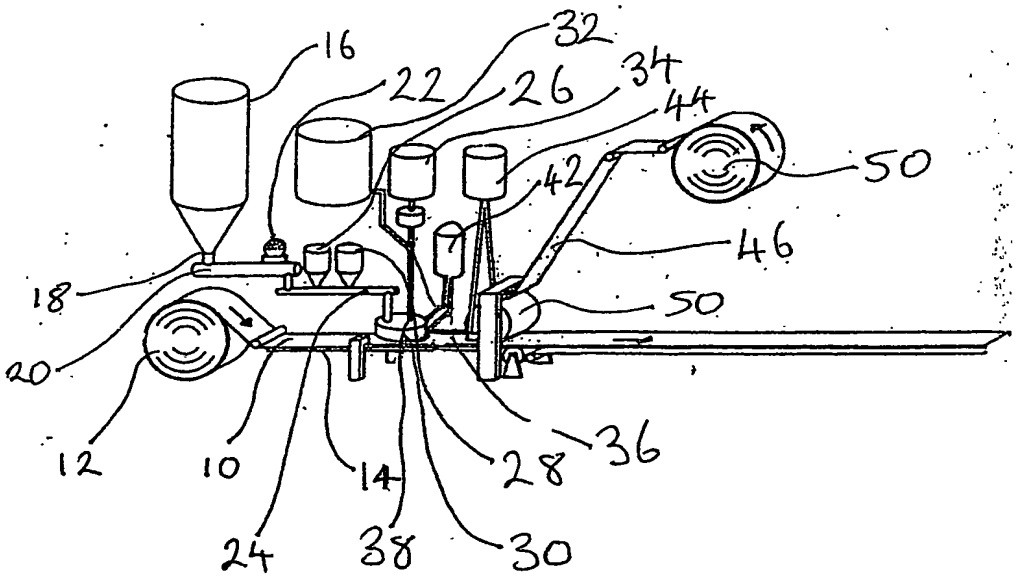


Figure 2

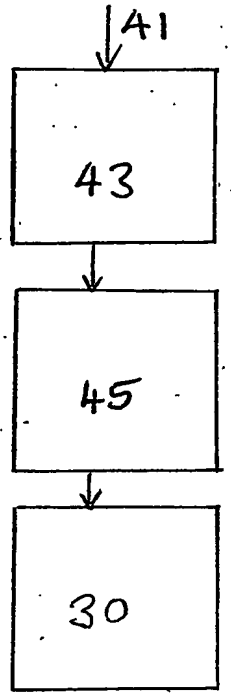


Figure 3

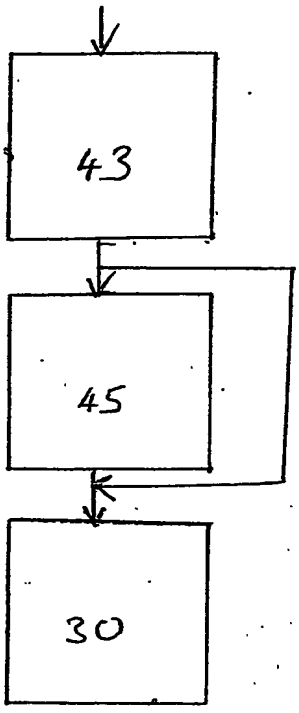


Figure 3a

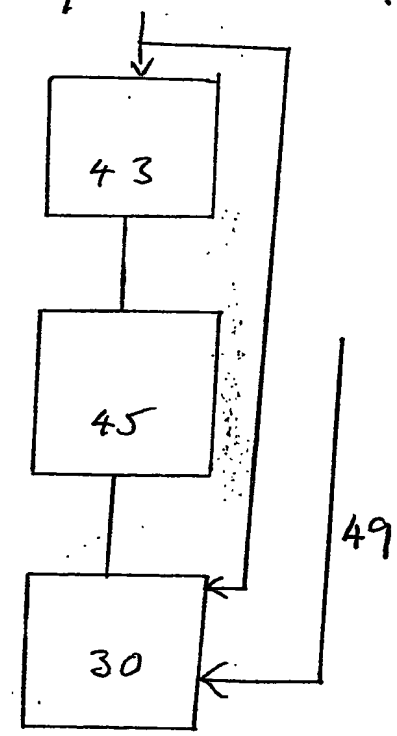
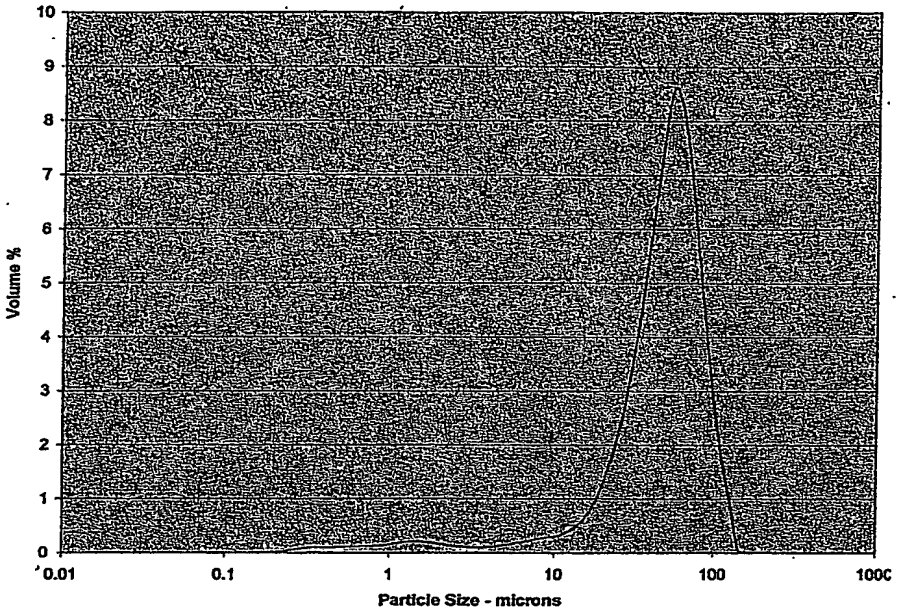


Fig 4


10
9
8
7
6
5
4
3
2
1
0
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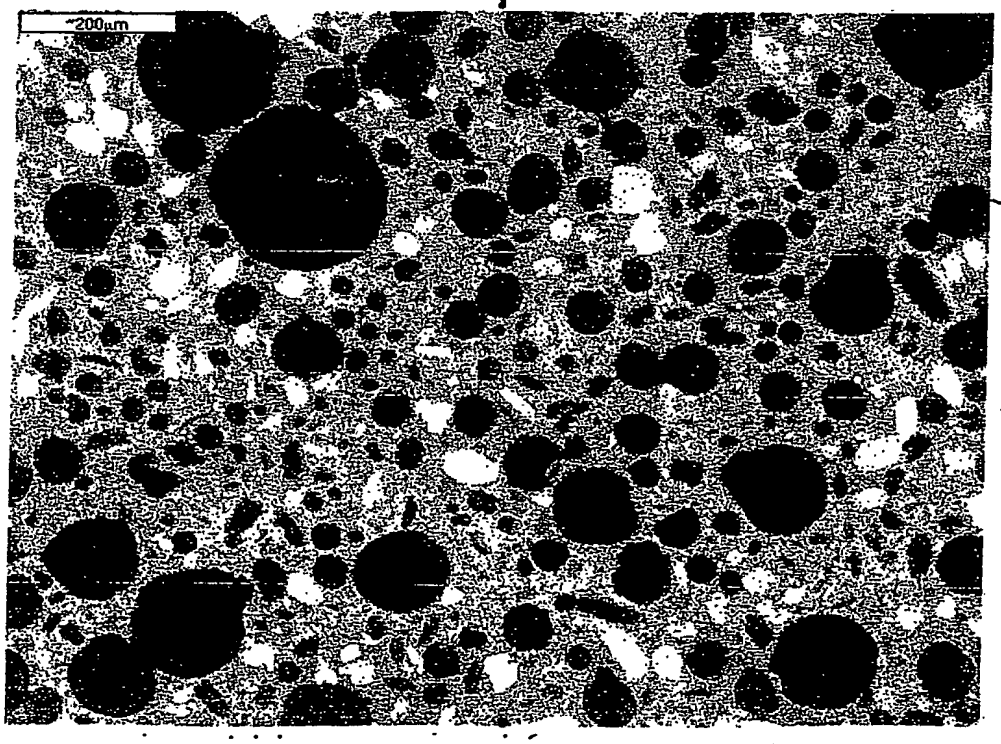
0.1
1
10
100
1000
Particle Size - microns

Fig 5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